

The SiD detector concept design study.

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Abstract. As part of the worldwide efforts for the International Linear Collider (ILC) three detector concept/design studies are being pursued, starting from different assumptions about what a general purpose detector at the ILC should look like to optimally extract the physics from such a machine. We are pursuing a detector where the complete tracking system is based on silicon pixel and strip sensors only, which allows us to build a more compact detector. This design study is a global effort, but the centers of activity are Fermilab and SLAC and their extended user communities.

Introduction

Since the ITRP decision in the summer of 2004 the different worldwide efforts on designing the International Linear Collider (ILC) have become very focused and coherent, using the cold accelerating technology choice as the common element for the design of the machine. A crucial ingredient in extracting the physics results from a future ILC are the planned detectors for the two interaction regions. To obtain the best detector performance possible, the ILC World Wide Study (WWS) group has called for global concept/design studies for these detectors. Currently three such design studies are being pursued worldwide for the detectors. Two are based on a gaseous type tracking chamber and therefore a larger tracking volume. The third one is based on using only semiconductor silicon devices in the tracking volume, thereby reducing its size and cost, while maintaining similar or better momentum resolution for tracks. This third design is simply referred to as Silicon Detector (SiD) and we will describe it and the assumptions it is based on below. SiD is the design which is being pursued by groups from, centered and associated with SLAC and Fermilab.

SiD Description and Assumptions

Very basic, but equally challenging requirements of any ILC detector are excellent momentum resolution for charged particles and excellent energy resolution for jet final states to be able to reconstruct for example W , Z and $Higgs$ bosons decaying to either charged lepton pairs and or quarks, which are measured as jets. To obtain this excellent jet energy resolution of order $30-40\%/\sqrt{E}$, particle/energy flow algorithms have to be used to measure the energy of jets in the calorimeters. This requires very fine and up to now unprecedented longitudinal and transverse sampling of the showers in the calorimeters. To keep the particle showers from spreading out

too much and thereby increasing detector volumes, and increasing cost, SiD proposes to use a compact tracking volume based on reliable, but advanced silicon detectors which are less sensitive to beam losses in a linear collider, followed radially by a compact and very dense Tungsten (W)–Silicon based electromagnetic(EM) calorimeter. The EM calorimeter is followed by a hadron calorimeter, which is contained within the 5Tesla solenoid. Outside the solenoid is the huge flux return which is segmented and serves as the muon detector. A schematic view of SiD is shown in Figure 1.

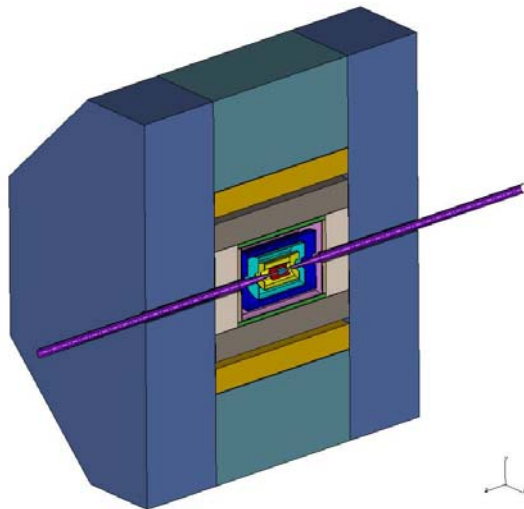


FIGURE 1. A schematic view of the SiD detector concept. More information can be found in Ref. 1

SiD Plans for Future and Needs & Fermilab activities

The above outline of the SiD detector concept is the starting point of the design study. The design study is in its beginning phase and one of the key ingredients needed over the next year and a half are physicists to participate in simulations studies. Based on studying the performance of the design for physics final states including W,Z and anticipated new particles, like the *Higgs* boson, will determine the final configuration of SiD. We anticipate to write up the results of these studies in a preconceptual design report which is due in the spring of 2006 and which will allow a comparison with the design studies for the other two detector concepts. While these studies are progressing, work on the design of the detector will continue as well, especially at SLAC and Fermilab. The combination of physics performance studies and design work is expected to identify a clear list of R&D areas to be studied in testbeams over the next few years. This R&D program will be a worldwide program, monitored and overseen by the above mentioned WWS. We see the SiD concept study as a starting point of an effort which will ultimately result in a proposal for one of the ILC detectors around 2008/2009.

At Fermilab we are involved in the following aspects of SiD:

1. The design, layout of the silicon based vertex and tracking detector. As part of this there will be an R&D program in monolithic pixellated silicon detectors for a vertex detector. Simulation of the tracking design is an integral part of this

effort and this is being put in place at the moment in collaboration with SLAC and other institutions. This effort covers many areas: physics simulation, detector design, electronics, detailed simulation of electronic properties of silicon devices, etc. It is one of the main areas of activity at Fermilab.

2. The hadron calorimeter is another detector where a lot of work is done by SiD members at Argonne National Lab and Northern Illinois Univ., both very close to Fermilab. These groups, collaborating with groups in Europe, plan to build three different prototypes of calorimeters, based on totally new technologies, to be tested in a Fermilab testbeam. This testbeam program will start in the summer of 2005 and continue for the next several years and is an integral part of the worldwide detector R&D efforts.
3. Layout and sensor R&D for the muon system are another main effort at Fermilab, including development of tracking algorithms for muons through multiple detector systems. This will be another testbeam activity over the next few years, coupled to the calorimeter testbeam work.
4. Together with Saclay in France, Fermilab is working on the feasibility study and design of the 5Tesla SiD solenoid, which pushes solenoid technology beyond its current limits.
5. The structural and mechanical aspects of the detector, with detailed engineering and modeling will also be done at Fermilab.
6. Although in its starting phases we expect that the Comp. Div. at Fermilab will play a very active and prominent role in defining the software and computing infrastructure for simulation and analysis. It should be noted that a first working version of this is in place, based on work at SLAC and Northern Illinois, and that simulation and analysis of these data can be done and is being done right now.

REFERENCES

1. More information about SiD, including many talks can be found at : <http://www-sid.slac.stanford.edu/>
2. Links to sources of information about the ILC, WWS, etc, can be found at : <http://ilc.fnal.gov/>